

Transportation Capital Programming in Massachusetts

prepared for

The Boston Foundation



by

Cambridge Systematics, Inc.

About Transportation Capital Programming in Massachusetts

This report, prepared for the Boston Foundation by Cambridge Systematics, Inc., in coordination with the Office for Commonwealth Development and the Massachusetts Executive Office of Transportation and Construction, makes recommendations for improving the way the State evaluates its transportation capital spending. The authors outline principles for the development of explicit, policy-driven criteria to guide investment decisions by focusing on two agencies that account for the most spending, the MassHighway Department and the MBTA. By setting out a framework that relates policy objectives to investment decisions, the report also provides a starting point towards the development of a more transparent regional planning process.

About Cambridge Systematics, Inc.

Cambridge Systematics provides management and planning consulting services and information systems to a broad mix of clients including local, state, national, and international agencies, and transportation, logistics, and manufacturing companies. Founded in 1972 by four Massachusetts Institute of Technology professors and a transportation consultant, the firm now has offices in Oakland, California, Washington, DC, Chicago, Illinois, and Tallahassee, Florida, as well as in Cambridge. Cambridge Systematics applies its analytic skills in five specific areas: transportation planning and management; intelligent transportation systems; commercial vehicle operations; asset management; and travel demand forecasting and market research.

The Boston Foundation

The Boston Foundation, one of the nation's oldest and largest community foundations, has an endowment of more than \$570 million and made grants of \$48 million to nonprofits last year. The Boston Foundation is made up of 750 separate charitable funds, which have been established by donors either for the general benefit of the community or for special purposes. The Boston Foundation also serves as a civic leader, convener, and sponsor of special initiatives designed to build community. For more information about the Boston Foundation and its grantmaking, visit www.tbf.org, or call 617-338-1700.

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Executive Summary

The Boston Foundation (TBF), in coordination with the Commonwealth Development Office (CDO) and the Massachusetts Executive Office of Transportation and Construction (EOTC), contracted with the firm of Cambridge Systematics, Inc. to develop an initial set of recommendations for improving the processes used to prioritize transportation capital spending in Massachusetts.

This study focused on the two agencies, which account for the majority of transportation spending in the State – the Massachusetts Highway Department (MassHighway) and the Massachusetts Bay Transportation Authority (MBTA). The MassHighway is responsible for the State highway system except for those roads under the management of the Massachusetts Turnpike Authority (MTA) – i.e., I-90 and the Central Artery project highways. The MBTA is responsible for the public transportation system in the Greater Boston area – including subways, buses, water transportation and commuter rail services. In the remainder of the State, public transportation services are operated by Regional Transit Authorities (RTAs), which are not directly under state control.

During the past decades, the Massachusetts transportation agenda has been dominated by several broad themes. The 1950s and 1960s were the era of interstate highway construction. The Sargent Administration imposed a moratorium on highway construction inside Route 128 in the early 1970s and initiated the Boston Transportation Planning Review (BTTPR). The BTTPR led to a shift in emphasis within the Boston region from highway to public transportation construction, specifically the use of Federal interstate transfer funds to construct the Orange Line/Southwest Corridor project and the extension of the Red Line to Alewife. These projects dominated the 1970s. The BTTPR also initiated the planning process, which culminated in the Central Artery/Tunnel (CA/T) project that has dominated the scene since the late 1980s.

During the CA/T era, the approach to setting other priorities for transportation investment in

Massachusetts has been fragmented and reactive, with each key agency developing priorities somewhat in isolation. The degree to which a well-defined set of objective criteria guides investment decisions may vary across these agencies. While agencies have attempted to develop a framework for priority-setting that relates statewide policy objectives to investment decisions, these approaches differ across agencies, making it difficult to understand the degree to which critical policies are actually being satisfied, and impeding analyses of tradeoffs across programs and modes.

An explicit, policy-driven, performance-based framework and criteria for guiding project prioritization now reflects “best practice” nationally. Such an approach would be a useful step for Massachusetts to take under any circumstances. It is even more crucial in the current transportation program context.

While construction of the CA/T project is nearing completion, the echo of this massive project is likely to continue to exert a major influence on state transportation decision-making for the rest of the decade in three ways:

- The need to pay off project bonds will continue to constrain state spending on other projects;
- Once the Federal government capped its commitment to the CA/T project in the mid-1990s, it wanted to ensure that the State did not tap into other funds to support the CA/T project. It therefore required that the State spend \$400 million annually on non-CA/T state roadway projects to ensure an equitable distribution of funding across the state and the maintenance in good repair of the entire state roadway system. This codified the State’s long-standing preference for maintaining an equitable geographic distribution of highway funding; and
- The transit mitigation commitments entered into by the State to ensure environmental approval for the CA/T project in 1990 have standing in a variety of legal settings. The purpose of these commitments is

to ensure that the state continues to pursue a modally balanced transportation investment strategy between transit and highways while making a massive funding commitment to the highway system. This commitment will help to ensure that the CA/T traffic volumes do not exceed forecasts and result in renewed congestion and environmental degradation. Transit projects not included in the CA/T commitments must either compete with the CA/T designated projects for limited funding, or be advanced as substitute measures which could accomplish the same objectives more effectively.

These three factors have limited the options faced by policy makers over the past decade and contributed to the current processes by which transportation spending decisions are made. Specifically:

- The costs of the CA/T project have constrained other spending, a situation compounded by the recent recession and resulting drop in state revenue.
- The need to ensure that the Federally mandated \$400 million on non-CA/T roadways was in fact spent every year (failure would have jeopardized Federal CA/T funding) and the State's desire to ensure a fair geographic distribution of transportation funding outside of the CA/T project, caused state officials to generate a significant pipeline of projects. Many of these projects, however, cannot be built for many years; and some will never be built. Sorting through this pipeline in a systematic way to move forward with projects of maximum value is one of the main challenges facing the current Administration.
- The CA/T transit commitments now constrain the Administration's freedom of action to select transit projects which today are perceived to be of maximum value and which meet new policies and goals. For example, the Administration has advanced the goal of linking transportation investment with smart land use planning. This goal may lead to a different set of priority projects than those currently put forward in the Central Artery environmental commitments.

In order to make the most cost-effective and productive transportation investments in an era of fiscal constraint, and to bring Massachusetts practice up to national standards, it is essential that the Administration engage in a logical and systematic process for evaluating and selecting highway and

transit projects. Resources and freedom of action are constrained – there is little margin for error. Decisions made today will set the State's transportation agenda for the next decade. Massachusetts lags behind many states in applying formal criteria and evaluation processes to transportation capital-spending decision-making. Politics can and should always play a role in such processes – it is, after all, the taxpayers' money. Nevertheless, objective processes and criteria can help to inform the political process and to establish priorities for use of scarce resources.

To this end, in the last two years state and regional agencies have already started to make significant progress. The MBTA has developed and applied objective criteria for selecting projects to go into its long-range Program for Mass Transportation (PMT), in the process reducing the project pipeline by some 75 percent. The MassHighway is currently working on a similar set of criteria to apply to highway projects. The Metropolitan Area Planning Council (MAPC) – the Metropolitan Planning Organization (MPO) for the Boston region, has developed similar criteria.

This study has attempted to move these processes forward with a series of recommendations, which will accomplish the following:

- Provide for similar processes and criteria to be used by both the MassHighway and MBTA while accounting for modal differences;
- Extend the use of these criteria throughout the planning processes from screening new projects being proposed to weeding out the backlog of projects to making final project selections; and
- Provide consistent guidance to state officials in their roles as participants in regional planning processes across the State as managed by Metropolitan Planning Organizations (MPOs).

The major recommendations of the study are as follows:

- Policy objectives should drive prioritization processes and criteria. The Administration has defined its transportation priorities as follows. Many of these criteria relate to the Administration's focus on using transportation to promote environmentally sustainable economic development strategies:
 - Preserving, modernizing and optimizing the existing system;

-
- Making efficient and effective system enhancement and expansion choices;
 - Concentrating development in infrastructure-rich, walkable areas;
 - Expanding housing opportunities where infrastructure and development opportunity coincide;
 - Improving mobility through modal choice and good safety and service; and
 - Minimizing adverse environmental impacts on the transportation system.
 - Program structure should reflect three basic categories of projects across agencies and modes:
 - Preservation;
 - Enhancements (i.e., “improvements”) to the existing system; and
 - System expansion.
 - Prioritization criteria should:
 - Reflect the most important transportation objectives;
 - Minimize additional data requirements where possible;
 - Consider threshold transportation criteria with supplemental criteria addressing non-transportation policy objectives;
 - Distinguish prioritization criteria (few, very focused) from categories of impacts (can be many);
 - Apply criteria to all project phases, including design; and
 - Apply criteria to all stages of program development.
 - The project nomination process should reflect the following:
 - Process should be formal, documented and transparent;
 - Project scope, cost and impacts should be documented at project nomination (while complete information will not be available at this stage, project proponents should be able to develop realistic order-of-magnitude estimates before a project advances further);
 - Needed mitigation should be included within project scope and cost;
 - Opportunities to leverage good community design and planning should be built into the criteria selection process;
 - Projects should be vetted earlier by an initial set of reviewers (for example, at the MassHighway, this could be done by District engineers adhering to agency-wide criteria), beginning at nomination;
 - Fiscal constraints should be introduced early in the process;
 - Candidate projects need to be managed throughout the entire length of the pipeline; and
 - Explicit organizational responsibility should be defined, along with procedural guidelines and decision criteria to approve changes to project scope and budget.
- This study was intended to be a starting point to provide guidance to the State in moving toward a more systematic project selection process. The following steps will need to be undertaken by the State as it moves the process forward:
- Obtain stakeholder input to the criteria and process for putting them into use;
 - Apply the criteria to specific projects – this can involve complex and lengthy analytical procedures;
 - Expand the process and criteria to possibly permit cross-modal (i.e., highway v transit, etc.) comparisons; and to consider which modes provide the most public benefit per dollars spent; and
 - Work with other agencies to develop their own criteria setting process to meet state and regional goals. This includes agencies not under direct state control such as Regional Planning Agencies (RPAs), RTAs, the MTA and Massport, as well as Metropolitan Planning Organizations (MPOs). While the Administration cannot compel these entities to adopt identical criteria, they can ensure that state officials apply the criteria in a consistent manner in their interactions with other agencies, and encourage other agencies to work with the State in the development of a common approach.

1.0

Study Background and Objectives

Historically, the approach to setting priorities for transportation investment in Massachusetts has been fragmented, with each key agency developing priorities somewhat in isolation. The degree to which a well-defined set of objective criteria guides investment decisions may vary across these agencies. While agencies have attempted to develop a framework for priority-setting that relates statewide policy objectives to investment decisions, these approaches differ across agencies, making it difficult to understand the degree to which critical policies are actually being satisfied, and impeding analyses of tradeoffs across programs and modes.

An explicit, policy-driven, performance-based framework and criteria for guiding project prioritization now reflects “best practice” nationally. Such an approach would be a useful step for Massachusetts to take under any circumstances. It is even more crucial in the current transportation program context. As the single project with overriding priority in the Commonwealth – the Central Artery/Tunnel – winds down, the State faces a critical funding shortfall across all areas. It is essential that other available transportation funds be programmed to the highest priority needs. Increasing levels of debt service will further constrain funding through the end of the decade, and investments aimed at preserving existing infrastructure and equipment will compete with more strategic investments to support economic development and community/environmental objectives. Needs in every area will far exceed fiscal and human resources. A key issue will be to program and allocate available funds as effectively as possible.

Ultimately, the framework for priority-setting should cover all modes of transportation: e.g., highway, rail, rapid transit and light rail, bus, marine, port and airport access, and pedestrian and bicycle, considering both passenger and freight needs and investments. From an institutional perspective, however, the highest-priority near term should be attached to the Massachusetts Highway Department (MassHighway) and Massachusetts Bay Transportation Authority

(MBTA), as the agencies spending the largest amount of money and being most directly under Gubernatorial control. For this initial phase of work, we have therefore focused on these two agencies that manage the core of the State’s highway and transit networks and account for the vast majority of spending. The work has also recognized that in both the highway and transit arenas, the State’s Metropolitan Planning Organizations (MPOs) play critical roles in transportation priority-setting under realistic fiscal constraints.

The interviews and gathering of data that were conducted in the initial phase of this work indicated substantial progress by both MBTA and MassHighway in working toward a more objective and transparent prioritization process. The MBTA has developed and applied objective criteria for selecting projects to go into its long-range Program for Mass Transportation (PMT), in the process reducing the project pipeline by some 75 percent. The MassHighway is currently working on a corresponding set of criteria to apply to highway projects. This study has attempted to move these processes forward with a series of recommendations that accomplish the following:

- Provide for compatible program structures, processes and criteria to be used by the Mass Highway and MBTA while accounting for modal differences;
- Extend the use of these criteria throughout the planning, prioritization, and delivery processes; and
- Provide consistent guidance to state officials in their roles as participants in regional planning processes managed by the MPOs.

This document makes reference to many technical transportation terms. A glossary of terms is provided in Appendix A to assist the non-technical reader.

2.0

Funding Availability for Transportation Capital Investments

The current context for transportation capital investments in Massachusetts is, at best, a difficult one. While the CA/T project is expected to be completed by 2005, the financial implications of this project are expected to extend into the next decade. As a result, the current funding environment for both the MassHighway and the MBTA is a difficult one, and will remain so for at least several years. Reasons for this situation are covered briefly below.

■ 2.1 MBTA

As part of the CA/T environmental impact agreement, the MBTA acquired the responsibility for several major transportation projects. These projects have been enshrined in various legal commitments. The purpose of these commitments was to ensure that the state maintained a balanced and multi-modal transportation program and continued to invest in both highway and transit projects. This commitment would help to ensure that the CA/T traffic volumes did not exceed forecasts and result in renewed congestion and environmental degradation. While originally intended as broad state commitments, funding responsibility for these projects has shifted in recent years from the State in general to the MBTA specifically. Since the passage of “Forward Funding” legislation, which sets an annual funding limit on the MBTA that must be met, there is no provision for subsidy of any additional costs incurred in advancing these commitments. Other state agencies – such as the MTA, which manages the CA/T project – have incurred no financial responsibility for meeting these commitments.

An illustration of the implications of the CA/T commitment projects and other demands on the MBTA’S capital budget is illustrated in Figure 2.1. Figure 2.1 shows the total value of projected capital projects in the next five years, as documented in the MBTA’S financially constrained Capital Investment Program (CIP). Total value of projects that can be undertaken in this period is estimated as \$2.8 billion.

The proposed commitment of funds is to Preservation, certain Enhancements, and two Expansion projects that are included in the CA/T commitments: the Greenbush commuter rail line and the Silver Line Bus Rapid Transit (BRT). The Preservation funding is required under the MBTA’S stated policy¹ of dedicating at least 70 percent of capital spending to system preservation projects to reduce a current \$3.0 billion backlog and forestall additional future needs.

FIGURE 2.1

MBTA Funding Environment Five-Year CIP Totals = \$2.8 Billion

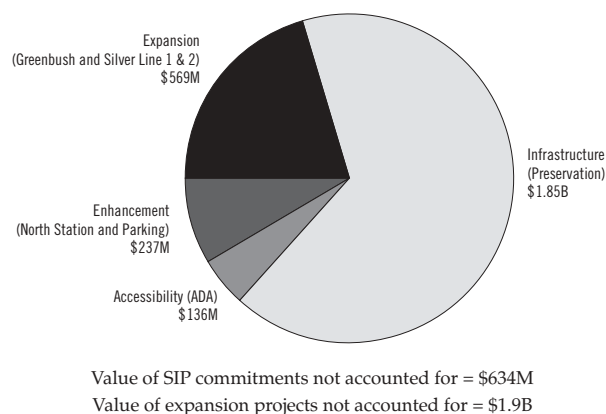


Figure 2.1² indicates that given this five-year projection, the cost of additional CA/T environmental commitments (many of them still in the planning stage) that are not included in the CIP total over \$600 million, and the cost of other expansion projects, also not included in the CIP, total almost \$2.0 billion. Thus, there is not sufficient funding to undertake current CA/T commitments and other Expansion needs. Later sections of this report will focus on procedures and criteria to prioritize Enhancement and Expansion projects, given this context of severely constrained funding.

¹ Policy is stated in the Program for Mass Transportation (PMT), May 2003, pp. 1-2, 1-3.

² Based on the best available data as of July, 2003.

■ 2.2 MassHighway

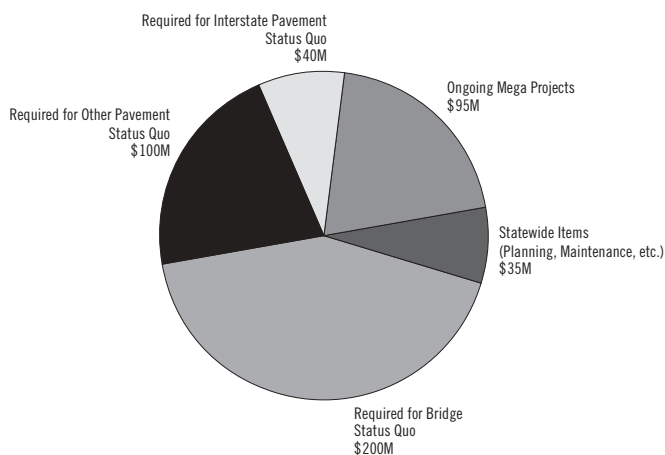
The State has long been sensitive to the need to ensure adequate investment in all elements of the roadway system and across all geographic regions of the state. Thus, the state made a commitment to spend \$400 million annually on highway projects across the state in the early 1990s. This commitment was later incorporated into the CA/T financing plan to ensure that the funding for non-CA/T roadway needs did not flow into the CA/T project. The need to maintain this commitment annually during CA/T construction strengthened an already existing need to identify projects and complete design, so a sufficient set of projects would be ready to advertise for bid each year. This process has contributed to the existence of about 1,300 projects in MassHighway’s pipeline, with many of them having completed or pending designs. These projects are now competing with new proposals for highway projects.

MassHighway’s current funding environment is shown in Figure 2.2. This chart does not reflect actual current expenditure levels, but the expenditure, which would be required to meet certain goals.

Figure 2.2³ indicates that once CA/T project obligations are accounted for, about \$470 million remains for other project work. If funds are allocated to preserve the existing pavements and bridges just to maintain status quo, to support maintenance and other statewide activities at current levels, and to fund ongoing “megaprojects,” the result is that no funds would remain for new or additional expansion projects. In subsequent sections, we will address prioritization criteria and processes for preservation and improvements to the existing system. In addressing these prioritization elements for system expansion projects, however, we will assume that the number of projects will be small for the foreseeable future.

FIGURE 2.2

MassHighwayFunding Environment Possible Annual Allocation after CA/T Obligations



Funds remaining for other enhancement or expansion projects = \$0

³ Based on the best available data as of July, 2003.

3.0

“Best Practice” Benchmarks and Key Elements of Approach

Selecting the most cost-effective projects is always important when spending the public’s tax dollars, but it is even more important in an era of fiscal constraints. Dealing with the funding issues described above will require program structures and prioritization processes and criteria that help managers make informed evaluations of project benefits and impacts on policy objectives. The significant advances already made by the MassHighway and the MBTA in this regard are a starting point but more needs to be done. The recommendations of this study build on this existing work, consistent with the following “best practice” benchmarks established through the Consultant’s experience with state DOTs nationwide.

Policy objectives should drive the prioritization process and criteria.

While improved processes and criteria can streamline the evaluation of project priorities, ultimately these elements must be rooted in the statewide policy objectives that govern an agency’s transportation programs. No amount of weighting, formulas, and calculations can substitute for clearly stated objectives on what the transportation program is intended to accomplish.

The Commonwealth has provided the following summary statements of relevant policy objectives:

- To preserve, modernize, and optimizing our existing transportation system.
- To use our limited financial resources for enhancement and expansion efficiently and effectively.
- To concentrate development in and promote redevelopment of areas that are infrastructure-rich and walkable.
- To expand housing opportunities, particularly by increasing access to infrastructure-rich areas with development potential.
- To improve mobility by ensuring that our citizens have a variety of modal choices, that our transportation system is safe and that congestion is reduced.

- To minimize the environmental impacts of the transportation system of the Commonwealth (i.e., to reduce air pollution, energy use, contaminated water runoff, and to preserve valuable ecosystems, etc.).

The program structure should reflect basic types of work across agencies and modes, supporting effective resource allocation.

There are many ways to visualize the structure of capital programs: i.e., by funding source, policy objective, type of infrastructure or fleet addressed, and so forth. To support effective resource allocation, however, experience has shown that organizing programs by the type of work performed helps to promote effective resource allocation, and is robust enough to apply to different modes and types of assets. A very effective program structure can be built in terms of three categories of work:

- Preservation of the existing system.
- Enhancements (i.e., “improvements”) to the quality of service of the existing system.
- Expansion of the system in terms of new capacity or new assets.

This structure happens to coincide with the current program categories adopted by the MBTA in its PMT. However, there are several strong reasons – in terms of good resource allocation practice – why such a structure should be adopted by the MassHighway and other agencies as well:

- By focusing on clearly identifiable, non-overlapping categories of work, the program structure encourages thinking about alternatives to meeting transportation needs: i.e., an operational improvement to existing facilities, construction of an updated facility, or investments in other modes to address a congestion problem.
- The program structure encourages thinking about impacts of projects across all policy objectives, not just a single objective. For example, a project that is

primarily a safety improvement may have development, housing, or environmental impacts as well. The program structure does not constrain one to focusing only on the “safety” objective.

- The program structure encourages tradeoff analyses to consider the implications of moving some percentage of dollars from one program category to another, and assessing the relative impacts in each program. The fact that the program categories do not overlap one another provides a clear basis for understanding this tradeoff.
- The program structure encourages thinking about different types and levels of investment in the face of budget constraints. If capacity expansions are too expensive, service enhancements may be possible at a more affordable cost. With respect to preservation, the program structure encourages consideration of preventive and corrective maintenance policies as well as capital investments.
- The program structure is easily adaptable to different modes and types of assets. The need for preservation is pervasive, applying to virtually all types of physical assets. Service enhancement and system expansion can be defined within the context of each mode and type of asset, by focusing essentially on investing in new assets or improving existing ones.

Follow best-practice guidelines in defining prioritization criteria.

- Keep prioritization criteria to a reasonable number, avoiding redundancy. It is not necessary, for example, to apply five measures of pavement condition in prioritization – in fact, doing so adds work and complicates decisions needlessly. Select the best measure – preferably one that relates to user benefit and comfort as well as signaling the need for agency investment – and use that one for prioritization.
- As a corollary to the previous item, distinguish between “prioritization” and “estimates of impacts.” Prioritization criteria should be few in number for efficient project evaluations. Project impacts are often more numerous, and are used to communicate the full implications of a project across many policy objectives.

- Reflect the most important policy and transportation objectives in the set of criteria. Again, the purpose of prioritization is to help evaluate projects for selection, and not to capture every impact of the project. However, undesirable impacts of a project may make it a low priority. By understanding the value placed on impacts, project proponents will design better projects. This will be a great benefit in the long-run. Focusing on the most important objectives will ensure that the resulting project evaluation is valid.
- Minimize additional data requirements where possible. Data collection and processing are expensive. As a starting point, select criteria that conform as closely as possible to existing data, but ensure that the data are of high quality. Moving forward, new and enhanced data sources will need to be developed to support analysis of evolving policies and goals.
- Consider an approach that applies prioritization criteria in two steps: the first, focusing on transportation criteria that meet some threshold benefit or positive impact; the second, focusing on other policy objectives. This approach will result in projects that are stronger in meeting both transportation needs and other statewide policies.
- Apply the same set of criteria to all project phases and to all stages of program development. While other criteria may be needed at specific stages (i.e., project readiness must be considered before bid advertisement), the criteria used to prioritize projects – i.e., to judge their merit and cost-effectiveness – should be the same throughout.

Implement a formal, documented, transparent process for project nomination and prioritization.

- Projects should be vetted throughout the process, beginning at nomination. This vetting process, moreover, should introduce financial constraints early, so that attention quickly focuses on those projects that are feasible candidates for selection.

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- Vetting projects earlier implies that good information on project scope, cost, and impacts should accompany the nomination form. A reaction can be anticipated to the effect that, “lacking project design, it’s difficult to estimate these impacts.” The responses are that 1) if this is the case, nominate the design phase itself for prioritization based on the best information available, and 2) make the best use of existing management systems and data processing tools to help provide needed information. DOTs with successful prioritization methods employ project nomination forms that request explicit information on scope, benefits, cost, and other impacts. This information is reviewed, with conversations with the project sponsor if needed, before the project can become a candidate for prioritization.
 - The impacts on the environment and any costs of needed mitigation for environmental, community, or other impacts should be included in the project scope, estimated cost, and impacts. Any resulting benefits to the environment, community, etc., should be reflected as a positive factor.
 - Once identified as a candidate, projects must be managed throughout the entire length of the process pipeline until completed. Changes in project scope or cost should be approved through a formal, documented review according to explicit criteria for approval authority vested in successive organizational levels.
 - The responsibilities of central office and district or field organizational units in participating in and managing this process need to be explicitly defined. It is important that all elements of an organization understand and buy-into the process. District units are generally more knowledgeable about the details of local conditions and the projects designed to improve them. They work closely with local proponents as well. In performing this important role of providing the agency with detailed local knowledge, it is important that they take and follow direction from central office policy makers and do not simply become advocates for local interests unfiltered by agency priorities. They could thus function as effective early screeners of projects shortly after a project has been nominated.

Applying Benchmarks to Recommendations

The benchmark practices cited above are applied to the capital project prioritization processes and criteria of the Massachusetts Bay Transportation Authority (MBTA) and the Massachusetts Highway Department (MHD) in Sections 4.0 and 5.0, respectively.

4.0

Recommendations for the Massachusetts Bay Transportation Authority

The best-practice benchmarks have been applied to the MBTA's current approach to capital investment prioritization to develop recommendations in three areas: the program structure, prioritization criteria, and prioritization process. The MBTA's current approach to preservation work is working well and, therefore, we have focused on better methods of incorporating policy considerations in prioritizing system improvements. While the discussion below covers all recommended program categories and criteria, a major part of the discussion gives attention to the two improvements categories used by the MBTA: Service Enhancements and System Expansion.

■ 4.1 Program Structure

The MBTA's capital program structure consists of three program components: Preservation, Service Enhancements, and System Expansion.

- **Preservation** is a program to maintain infrastructure and fleet assets in a state of optimal repair. Projects in the PMT are identified by mode: commuter rail, rapid transit, bus or trackless trolley, boat, and other modes, including pedestrian and bicycle. Specific categories of infrastructure and fleet are identified within each mode.
- **Service Enhancements** improve the quality of service of the existing system. The PMT groups enhancements in three categories: General Enhancements, Accessibility Enhancements (i.e., to improve accessibility for passengers with disabilities), and Access to Service (i.e., to improve general access to transit stations, such as parking expansion, installation of bicycle racks, and improvements to pedestrian approaches). Projects in each category are evaluated against others in the category for the same mode. For purposes of PMT prioritization, modes are considered to be rapid transit, commuter rail, bus or trackless trolley, and other modes, including non-motorized modes.

- **System Expansion** adds new capacity by extending lines to areas not now served, implementing service on an existing line during times not now served, or changing the mode of transportation on an existing route. The PMT organizes projects in two groups: expansion projects within Massachusetts, and multi-state expansion projects (i.e., to extend commuter rail to New Hampshire and Rhode Island). Projects in each group are evaluated against others in the group for the same mode: rapid transit, bus or trackless trolley, commuter rail, and other modes.

The MBTA program structure conforms to benchmark guidelines, and appears to work well in supporting project prioritization in the PMT. This study recommends retaining the program structure with no change.

■ 4.2 Prioritization Criteria

Prioritization criteria are discussed by program category. The descriptions below review criteria now applied by the MBTA, and follow with recommendations for improving the process according to best-practice benchmarks.

Preservation

Preservation needs are evaluated using time-based guidelines that relate to the life cycle of infrastructure components or fleet equipment. These measures include age and useful life of the asset, and recommended times for maintenance and rehabilitation. The MBTA maintains an automated database and analytic tool – The Systemwide Condition Assessment and Capital Investment Program Database and Forecasting Model – to assist in identifying needs and priorities for both infrastructure and fleet.

These time-based measures are adequate for predicting preservation needs. Moreover, they have the advantage of applying to a wide variety of

infrastructure and fleet components. The modeling of deterioration of both facilities and fleet is often based on in-service time or asset age. No changes in this approach are recommended at this time. Over the long term, the MBTA should consider developing relationships between these time-based measures and knowledge of the technical condition of key assets (refer to Section 6.0 for additional information).

General Enhancements and System Expansion

Among the three categories of Service Enhancements, the General Enhancement projects are the most numerous and present the greatest challenge in prioritization. Accessibility Enhancements and Access to Service are more focused improvements, dealing with specific station locations and characteristics. Accessibility enhancements are largely driven by the need to comply with the Americans with Disability Act (ADA). The discussion below therefore is directed to General Service Enhancements. Moreover, since the MBTA applies the same prioritization criteria to System Expansion, the discussion and recommendations apply to the Expansion program as well.

Currently Used Criteria

The MBTA now applies seven criteria to prioritize General Enhancements and System Expansion projects:

- **Utilization**, measuring ridership and attendant benefit measures;
- **Mobility**, gauging access to transit services;
- **Cost-effectiveness**, computed as ratios of capital or operating costs to selected, non-monetary benefits;
- **Air quality**, gauged in terms of two types of measures: percentage reductions in several types of pollutants, and cost-effectiveness in terms of the ratio of total project capital construction costs to pollutant reductions;
- **Service quality**, reflecting passenger security and comfort, reliability of service, and quality of information given to passengers;
- **Economic and land-use impacts**, describing access to transportation services within certain identified neighborhoods or sections (applied to System Expansion projects only); and

- **Environmental justice**, expressing the degree to which the project serves disadvantaged populations.

A total of 35 performance measures are evaluated among these seven areas. Ratings are expressed in terms of high, medium, or low values for each of the 35 measures. Scores are then aggregated to arrive at overall ratings for each of the seven criteria.⁴ These aggregate evaluations of the seven criteria are used to prioritize the projects.

Recommended Criteria

The MBTA's approach appears to work well – in the most recent application in the development of the Program for Mass Transportation (PMT), more than 400 projects were screened to reduce the candidate pool to about 140. The range of criteria considered, and the ease of communicating results in terms of High-Medium-Low impacts, helped contribute to this evaluation with little or no objection from stakeholders. There are, however, some improvements that would strengthen the validity of the results, provide clearer indications of project merit, and simplify the set of 35 performance measures:

- **Consider the criteria in two stages:** an initial stage to evaluate the transportation performance and cost-effectiveness impacts of a project, and a second stage to consider other impacts or other policy objectives.
- **Reorganize and streamline the performance measures** among the seven criteria to include important transportation measures within Mobility and Utilization, eliminate potentially misleading measures, and eliminate redundant measures.
- **Quantify key transportation impacts.**

Consider criteria in two stages. Evaluating transportation criteria first ensures that projects passing this initial screen represent valid solutions to transportation needs, and are therefore more likely to perform successfully. The evaluation of the Mobility, Utilization, and Cost-effectiveness criteria can be either relative (i.e., select the top 20 or 30 percent of the projects), or based on a threshold value developed through experience as a useful guide to likely project success (i.e., select projects that serve at least some threshold ridership level). Other criteria supporting

⁴ In aggregating scores, H-M-L ratings are considered to have values in the ratio of 3 to 2 to 1, respectively.

economic, environmental, and other policy objectives then can be evaluated on the set of projects passing the transportation screen. This second-round evaluation can be used as a “tie-breaker” to further distinguish the set of superior projects. It can also be used to adjust the ranking of projects where non-transportation objectives are felt to be an important consideration, as expressed through community support, very strong environmental justice benefits, positive environmental impacts, and so forth. The fact that all projects in this second-stage-evaluation pool represent good transportation solutions lends validity to any subsequent adjustments in priority. These adjustments should be documented to add transparency to the process and as a matter of record. This dual or two-tiered approach will strengthen not only the transportation benefits in the highly ranked pool of projects, but also will increase the likelihood of successfully meeting non-transportation policy objectives, given the greater likelihood of successful project performance.

Reorganize and streamline performance measures embedded in the prioritization criteria. While the 35 performance measures collectively gauge useful aspects of projects, reorganizing them and reducing unnecessary or potentially misleading measures will result in a stronger, more meaningful evaluation across the seven criteria. For example:

- Redundant measures should be eliminated: i.e., one of several ridership measures should be selected as the key metric, and the others dropped.
- Potentially misleading measures should be eliminated: i.e., the cost-effectiveness measures now associated with environmental improvements, which compare total project cost (i.e., the cost to meet a number of policy objectives) to only a single project benefit (i.e., the reduction in pollution).
- Measures of transportation performance now included in the System Quality criterion should be considered in the transportation-related Mobility and Utilization criteria. These measures include system reliability, interconnectivity, and number of transfers.
- New measures should be considered that capture transportation impacts more comprehensively or accurately. These measures can replace one or more existing measures. Recommendations are detailed

in the section entitled, “Recommended Transportation Measures.”

Quantify key transportation impacts. Quantification encourages clearer thinking as to what a project will contribute to transportation performance. Even if the quantification is approximate (as it will typically be prior to project design), it causes an examination of existing performance and the expected degree of improvement based on historical experience with similar projects. Mobility and Utilization measures should be quantified to the greatest extent possible, including the new measures that are recommended for inclusion in these criteria such as system reliability and number of transfers. Here, as in the case of the MassHighway, the intent is for project proponents and initial reviewers to develop order of magnitude estimates using standard basic performance measures, historical performance of similar projects, and sketch planning analytical tools.

■ 4.3 Recommended Transportation Measures

The cumulative effect of the recommendations above can be illustrated by a revised set of measures in each priority criterion. Threshold values have been developed by the Federal Transit Administration (FTA) to support its review of state projects submitted for Federal funding. These threshold values can be used as a starting point for the MBTA’s project evaluation process. However, the State should feel free to adjust process and criteria for its own internal evaluation purposes. The FTA threshold values are shown in Appendix B. It is recommended that the State might want to consider variations in the FTA approach in two specific areas:

- Incorporation of projected fare revenue as an offset to project operating costs (i.e., net vs. gross costs) in order to credit projects which are projected to have higher than average cost recovery ratios given the MBTA’s historically poor performance in this regard relative to other large urban systems; and
- Quantifiable consideration of the synergistic impacts of transportation investment and land development in order to credit projects which encourage higher density development. While current FTA processes do allow for an implicit consideration of this impact, the quantifiable impact

of a project must be compared to the impact of the No Action Alternative against the same growth forecast, even though that forecast might be altered by the implementation of the project.

Utilization

Broaden the measurement of utilization by considering the **overall reduction in transportation user cost**. User costs consist primarily of out-of-pocket costs such as fares and parking, and a monetized value of time.

- This measure should be quantified for both existing users and new users (i.e., current transit riders and users expected to divert from other modes to the transit mode as the result of the project).
- The measure captures the direct transportation benefit to customers due to increased ridership resulting from improvements in access to the system, in mainline average travel speed, in system reliability, and in transfers and connections.
- Reduction in total travel time can be used as a proxy if data are not sufficient to estimate user cost savings.
- Other statistics now computed for Utilization (i.e., mode share, reduction in highway vehicle miles traveled [VMT]) can be displayed as project impacts for use as supporting or clarifying data, but need not be used as prioritization criteria.

Mobility

The interpretation of Mobility should be **broadened to include system reliability, interconnectivity, and transfer measures** here rather than in Service Quality. These measures should reflect the quantitative improvement in service due to the project. If models are not available to predict these improvements, they can be estimated based on historical experience with similar projects. While these measures may reflect some subjective evaluation, it should also be possible to make informed predictions of these service characteristics. The improvement in each Mobility measure can provide technical input to the estimated reduction in user cost discussed above in the Utilization criterion.

Cost-Effectiveness

The MBTA now employs four cost-effectiveness ratios: two based on capital costs, and two based on annual operating costs. These provide a point of departure for defining a **single new measure built on both capital and operating cost and on total customer benefit** that would replace the existing ratios:

- The new measure should include total ridership benefits – the overall reduction in user costs computed in the Utilization criterion.
- The new measure should include annualized capital cost and annual operating cost attributable to the project.
- The measure can be structured as a benefit/cost ratio:

$$\text{Cost-Effectiveness} = \frac{\text{Total Reduction in User Costs Due to Project}}{\text{Annualized Capital Cost} + \text{Annual (Gross) Operating Cost}}$$

Cost-effectiveness should meet or preferably exceed a threshold value of 1.0.

In addition to the new cost-effectiveness ratio, a second new measure can be defined to capture the fare recovery ratio associated with the project: i.e., the ratio of additional annual revenue due to the project to the annualized capital cost plus operating cost:

$$\text{Fare-Recovery Ratio} = \frac{\text{Additional Annual Revenue Due to Project}}{\text{Annualized Capital Cost} + \text{Annual Operating Cost}}$$

4.4 Recommended Measures for Other Policy-Based Criteria

Air Quality

The technical measures of air quality improvement are now expressed as percentage reductions in four pollutants: carbon monoxide (CO), carbon dioxide (CO₂), volatile organic compounds (VOC), and nitrogen oxide (NO_x). There are also four cost-effectiveness measures defined as the ratio of project capital cost to the total reduction regionwide in each of the four pollutants, respectively. Recommendations are as follows:

- To replace the percentage reduction measures with **total annual tonnage reductions** regionwide of three of the four pollutants above (CO is no longer a problem in Massachusetts).
- To add corresponding **tonnage reduction measures for ozone and particulates**.
- To eliminate the **cost-effectiveness measures for air quality** – cost-effectiveness will be dealt with as discussed in the preceding section.

Service Quality

The recommended focus of this criterion is on passenger safety and security, passenger comfort, and provision of customer information. Existing measures in these areas can continue to be used. Other measures now included in this criterion dealing with reliability, interconnectivity, and transfers should be considered in Mobility and Utilization, as discussed earlier.

Economic and Land Use Impacts (System Expansion Only)

While existing measures of land-use impacts are a start, the importance attached to this potential benefit of transportation investment by the current Administration prompts consideration of more robust, quantitative measures. Recommended measures are specified in Appendix C in the following areas:

- Service to **existing urbanized areas, brownfields, and infill areas**.
- **Population and employment centers** that are served.
- **Character of existing land use** at a project station location.
- **Transit-supportive zoning** in station areas.

The first three groups of measures estimate benefits in the current economic and land-use context. The fourth group of measures, by considering current zoning, attempts to anticipate the evolution of land use and economic activity in the future.

Federal Transit Administration (FTA) guidelines for New Starts funding require that in evaluating transit project impacts, the future land use pattern must be assumed to be the same whether the proposed project is built or not. This assumption is unrealistic in cases where a project is envisioned to change local economic

activity and land use. The MBTA has the option to consider alternative land-use futures in its own evaluation of project merit, separate from any submittals to the FTA that must assume a static land-use scenario.

Environmental Justice

The MBTA now has four measures related to service to minority, disadvantaged, and transit-dependent populations, the relative costs and benefits conferred on these populations, removal of barriers between these populations and employment centers, and response to environmental justice issues raised in MPO plans. These measures should be retained, and no further recommendations are made.

4.5 Prioritization Process

The current MBTA prioritization and selection process spans four stages:

- The Program for Mass Transportation (PMT), a 25-year prioritized program of projects (not fiscally constrained);
- The Boston MPO Regional Transportation Plan, a three-year plan that is fiscally constrained, including Federal funding;
- The Capital Investment Program (CIP), a five-year document that implements the PMT, including all sources of funding; and
- The Transportation Improvement Program (TIP), a three-year, prioritized program updated annually.

This process has worked well. Recognizing that this PMT-driven process has only recently been instituted, we recommend, and the MBTA concurs, that the prioritization criteria and approach described for the PMT in the preceding section should be extended to the CIP as well.

5.0

Recommendations for the Massachusetts Highway Department

The best-practice benchmarks of Section 3.0 have likewise been applied to the MassHighway's current approach to capital investment prioritization to develop recommendations in program structure, prioritization criteria, and prioritization process. The key elements of these recommendations are:

- A simpler program structure, reflecting basic types of work rather than functional class;
- A focus on Preservation as the Commonwealth looks beyond the CA/T project; and
- A relatively simple program structure and prioritization approach for Service Enhancements and System Expansion for now, given scarce funding for these types of projects.

■ 5.1 Program Structure

In its draft proposals for a prioritization process, the MassHighway has considered a program structure that recognizes different types of work (preservation and improvement) in the context of highway functional class. While functional class helps to distinguish those highways that are eligible for Federal Aid,⁵ such a program structure tends to limit solutions too narrowly by these individual functional classifications. The recommended approach is to simplify the program structure to consider basic categories of work alone: Preservation, Service Enhancements, and System Expansion. This would permit the consideration of all state road projects across functional category and funding eligibility. Eligibility for Federal Aid can be handled through the project identification and prioritization process itself as a matter of eligibility, rather than through the program structure. The resulting program structure for highways would be organized as follows:

- **Preservation** maintains assets in a state of good repair. The program would include capital rehabilitation, repair, and "major maintenance" projects, and replacement of assets in kind – i.e., with no capacity expansion or bridge widening (replacing bridges "on the same footprint" would be a Preservation action). The Preservation program can include subprograms for **Pavements, Bridges,** and if needed, **Other Structures.**
- **Service Enhancement** improves the capacity or level of service of the existing highway system. Subprograms could include:
 - **Highway Enhancements**, encompassing several types of work:
 - ◆ Minor capacity projects such as spot improvements: i.e., climbing or passing lanes;
 - ◆ Intersection and interchange improvements;
 - ◆ Operational improvements such as enhanced signal controls and installation of Intelligent Transportation System (ITS) devices; and
 - ◆ Intermodal connections such as park-and-ride facilities.
 - **Safety** projects including, for example, geometric improvements to roadway design and bridge widenings which improve safety by increasing lane widths or adding shoulders but which do not add capacity;
 - **Ancillary facilities** such as rest areas;
 - **Bicycle and Pedestrian** ways added to existing facilities; and
 - **Travel Demand Management** projects such as ridesharing programs.

⁵ Highways eligible for Federal Aid would be distinguished from "Chapter 90 roads," local highways that are not eligible for Federal Aid.

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- **System Expansion** includes projects that add new capacity to the system, including additional general-purpose or HOV lanes; bridge replacement or reconstruction on a different footprint which result in additional capacity; and new roadways, major upgrades in functional class of an existing route, and new bridges. No individual subprograms are recommended at this time, since the number of Expansion projects should be limited due to constrained funding. Individual projects can be identified and analyzed within the overall program umbrella.

It is not unusual for highway projects to include more than one category of work, and thus to cross program categories. For example, a project may preserve the existing system, but also include safety improvements. Recommendations for evaluating these types projects are as follows:

- If the work components are separable, they should preferably be listed within the respective programs and prioritized separately. For example, the preservation component should be prioritized within the Preservation program; and the safety component, within the Safety subprogram under Service Enhancements.
- If the work components are not separable, the project should be listed and prioritized according to the primary focus of the project: either Preservation or Safety.
- Preservation projects should be allowed to include minor spot safety work without the need to split work components as described above. However, the limits on this spot safety work must be defined explicitly and tightly enforced. Limits are more easily managed at a program rather than an individual project level. This approach provides flexibility in defining projects, but meets the need for a transparent and orderly categorization of projects.

■ 5.2 Prioritization Criteria

Prioritization criteria are discussed by program category. The descriptions below build on criteria now applied by the MassHighway, and include recommendations for improving the process according to best-practice benchmarks.

Preservation

Pavement

Preservation needs in the **Pavement** subprogram are evaluated using MassHighway's pavement management system (PMS). The PMS predicts the decline in a measure of pavement surface condition, the present serviceability index (PSI), and recommends remedial treatments and their timing to restore pavement surface condition and structural strength if needed. Site visits in districts can confirm PMS recommendations, help identify and diagnose problems requiring attention, and identify spot safety needs.

The recommended timing of pavement projects to address serviceability, structural, and friction needs in effect defines a prioritized list of pavement projects. The MHD should communicate the rationale and recommended timing of these projects to MPOs and other stakeholders as a matter of transparency. It should also be made clear that over the long term, pavement preservation projects will be distributed equitably statewide. Furthermore, the coverage of the PMS should be extended to all state-funded roads (not only the numbered state highway system), an improvement that the MassHighway recognizes.

Bridge

Bridge projects are identified and prioritized by the MassHighway's Pontis⁶ bridge management system (BMS), with recommended treatments and timing analogous to the process described for pavements.⁶ These recommendations can be reviewed and refined in the MassHighway central office to develop projects for nomination.

⁶ Bridge conditions are inspected at least every two years, as mandated by federal law. Bridge condition is tracked in Pontis in two ways: a National Bridge Inspection (NBI) rating, and a more detailed condition rating of individual bridge components or "elements."

Other Structures

If other structures (such as retaining walls, park and ride lots, garages and bikeways) are sufficiently numerous to warrant a formal prioritization process, a recommended approach is to devise a quantitative measure of condition: i.e., on a scale of 0-100, with ranges corresponding to Excellent, Good, Fair, Marginal, and Poor condition. The interpretation of these condition ratings should be documented and illustrated in a guidebook, with recommended treatments and priorities for action. It would also be advisable to institute a schedule of periodic inspections for condition rating, if not already conducted now.

Service Enhancements and System Expansion

The MassHighway has proposed new criteria to prioritize highway improvements that correspond to the General Enhancements and System Expansion programs. MassHighway is proposing to apply these criteria **in two stages**: an initial stage to evaluate the transportation performance and cost-effectiveness impacts of a project, and a second stage to consider other impacts in other policy objectives. Once again, evaluating transportation criteria first ensures that highway projects passing this initial screen represent valid solutions to transportation needs, and are therefore more likely to perform successfully.

Other criteria supporting economic, environmental, and other policy objectives can then be evaluated on the set of projects passing the transportation screen. This second-round evaluation can be used as a “tie-breaker” to further distinguish the set of superior projects. It can also be used to adjust the ranking of projects where non-transportation objectives are felt to be an important consideration, as expressed through community support, strong environmental justice impacts, environmental benefits, and so forth. The fact that all projects in this second-stage-evaluation pool represent good transportation solutions lends validity to any subsequent adjustments in priority. These adjustments should be documented to add transparency to the process and as a matter of record.

This dual or two-tiered approach will strengthen not only the transportation benefits in the highly ranked pool of projects, but also will increase the likelihood of successfully meeting non-transportation policy objectives, given the greater likelihood of successful project performance. Since the recommended application of this approach regarding the transportation criteria differs somewhat between Enhancements and Expansion, the two programs are explained separately below.

■ 5.3 Recommended Transportation Criteria for Enhancements

The recommended transportation-related measures at this point reflect a simple approach that builds on the considerable work that the MassHighway has accomplished and minimizes the effort needed for implementation and data collection. Several options are indicated below, and the MassHighway should select the one that can be best accomplished now, with a goal of moving to more advanced criteria in the future. The options are all based on a benefit/cost analysis or a cost-effectiveness measure.

Mobility Improvements

We recommend that in analyzing Mobility improvements, MassHighway should organize separate lists of urban and rural candidate sections. This approach recognizes the different nature of urban and rural mobility improvements, and helps to ensure a geographic distribution of projects to meet the goal of geographic equity. It might even be desirable to consider a third suburban/exurban category.⁷ Within the urban and the rural lists, the mobility benefits should be estimated using one of the following options, in decreasing order of preference:

- User benefits or reductions in user costs of travel, considering the costs of travel time, vehicle operation, and accidents; or
- Travel time savings to passenger and commercial users of the highway system; or
- Improvement in highway level of service (LOS), weighted by daily traffic volume.

⁷ Federal urbanized maps could be used to provide an objective geographic delineation.

The Mobility prioritization criterion can then be calculated for each project, depending upon the benefit measures selected above:

- Benefit/costs analysis; or
- The ratio of discounted value of time savings to discounted project cost; or
- The ratio of discounted project cost to the LOS improvement weighted by daily traffic volume.⁸

Intermodal and Interconnectivity Improvements

Park-and-ride facilities are the dominant project now considered in this category, but other types of projects can be assessed in a similar way. The recommended prioritization criterion is to estimate usage of the facility and prioritize based upon a cost-effectiveness measure, the ratio of annualized capital cost plus annual operating cost to the annual usage. (Such facilities could also be analyzed as part of the MBTA process.)

Safety

Urban and rural safety projects should be analyzed separately. Prioritize according to cost-effectiveness as follows:

- Estimate the cost savings due to accident reduction at each high-hazard location (HHL) using standard measures of the value of property damage, personal injury and fatalities; and
- Develop the cost-effectiveness criterion as the ratio of discounted accident reduction cost to discounted cost of project.

Bicycle and Pedestrian Enhancements

- Estimate the usage of the facility (i.e., daily numbers of persons, person-miles for bike paths);⁹ and
- Prioritize based on cost-effectiveness, computed as the ratio of discounted project cost to number of persons or person-miles served.

Travel Demand Management

- Estimate the reduction in demand on targeted facilities; and
- Prioritize based on cost-effectiveness, computed as the ratio of project cost to total reduction in demand.

5.4 Recommended Transportation Criteria for Expansion

The recommended application of transportation criteria to Expansion projects differs from that for Enhancements:

- Urban and rural Expansion projects should be evaluated competitively, rather than separately, given their major scope and cost and the fact that the number of projects is likely to be small. Nevertheless, it is likely that some reasonable geographic distribution of these projects will be required over time.
- Expansion projects should be evaluated on the basis of a benefit/cost analysis, rather than a cost-effectiveness ratio or other surrogate. The benefits component of the benefit/cost calculation should include costs savings in travel time, vehicle operation, and accident reduction, as applicable to each project.

5.5 Recommendations for Other Policy-Based Criteria for Service Enhancements and System Expansion

Other policy-based criteria, again reflecting recent work by the MassHighway, include:

- Support of housing opportunities;
- Support of economic development or job creation;
- Support of sustainable land use; and
- Support of environmental quality.

We recommend that each of these criteria be treated in a manner similar to the MBTA's evaluation of other policy-based criteria: to develop guidelines for

⁸ Annual average daily traffic, or AADT.

⁹ It is recognized that current methods for forecasting demand for such facilities are embryonic, but there is considerable research on this issue underway and thus there are reasonable prospects for improved methodologies in coming years.

evaluating each criterion in terms of a High, Medium, or Low impact, and to reflect these evaluations in a matrix for prioritization. The guidelines for scoring should be quantitative where possible (refer to recommended land-use criteria in Appendix C for examples), and should be documented with examples. High rankings of projects across these criteria can be used by the MassHighway as a “tie-breaker” for projects with similar transportation benefits and costs, and as a basis for adjusting the priorities of projects where these other policy objectives may outweigh the initial ranking reflecting only transportation impacts. It will be necessary to further develop data and analytical methods for analyzing these criteria, but there is a great deal of national research underway on how best to link transportation and land use related criteria.

■ 5.6 Example of Highway Prioritization

Highway project prioritization is proposed as a two-tiered process:

- Evaluation of transportation-related impacts in terms of a benefit-cost analysis or an approximation (surrogate) to this type of analysis; and
- Evaluation of other policy-related goals.

The analysis of transportation costs and benefits can be done in a number of ways: i.e.,

- By applying software that analyzes solutions on a life-cycle cost basis;¹⁰
- By developing standardized procedures to analyze typical transportation situations in a benefit-cost framework;¹¹ or
- By computing agency and road user cost streams anticipated with and without a project, applying engineering-economic principles to estimate the discounted cost and discounted benefit of the project, and developing a benefit-cost result.

At a minimum, the transportation benefit-cost ratio should equal at least unity, indicating that the project returns at least as much benefit as the cost incurred.

Projects that are especially beneficial will have a benefit-cost result that exceeds 1.0. This test of whether the B/C ratio equals at least 1.0 is a critical filter – the project should represent at least a good transportation solution. Projects for which B/C is less than 1.0 should be eliminated from further consideration. A similar approach should be applied for those projects for which a cost-effectiveness criterion applies (i.e., ratio of cost to number of passengers served). Projects that are most efficient (i.e., lowest cost per passenger served) should be given higher priority from a transportation perspective. Regardless of the measure used, the cost of the project must also be feasible given the anticipated program budget. (It is for this reason that we recommend that financial constraints be considered at the project nomination stage, not later).

The second-tier analysis concerns other policy objectives identified by the Governor as statewide priorities for transportation: support of, respectively, land use, housing, economic development, and environmental quality. A qualitative “High-Medium-Low” rating scheme is recommended, much like that employed by the MBTA, but these ratings may be based on quantitative analyses if available.

Assume that the information provided at project nomination yields the following results for a set of projects:

Project	Cost	B/C	Land Use	Housing	Economic Development	Environment
A	\$2.7 million	4.2	L	H	H	M
B	\$1.9 million	3.5	H	H	M	L
C	\$3.3 million	2.6	M	L	M	L
D	\$3.5 million	2.2	M	H	H	H
E	\$3.6 million	1.9	M	H	H	M

¹⁰ Examples include the FHWA’s Highway Economic Requirements System (HERS) or the version developed for statewide planning (HERS/ST), and MicroBenCost (available through the PCTrans clearinghouse). MHD’s Pontis® bridge management system also operates using a life-cycle cost analysis.

¹¹ For example, a comprehensive set of benefit-cost procedures for Mobility projects has been developed by Washington State DOT: **WSDOT Mobility Project Prioritization Process: Benefit/ Cost Software Users Guide**, prepared by Dowling Associates, Inc. in conjunction with Kittelson & Associates, May 2000.

The projects in this example pass the initial transportation criteria and all provide some benefit toward other policy objectives. They total \$15 million in cost.

As a first cut, the list is organized in decreasing order by B/C ratio. Note, however, that there are differences in the degrees to which the projects are anticipated to meet the other policy objectives. MHD may therefore adjust priorities to reflect these other policy interests. For example, while projects C, D, and E all have similar cost, D and E are superior to C in addressing non-transportation policy objectives. MHD may therefore elevate the priorities of D and E above that of C to signal the importance of the Housing, Land Use, Environmental, and Economic Development objectives. This adjustment should be acknowledged explicitly with the reasons for making it. The adjustment continues to provide a valid transportation solution as well, since C, D, and E all have respectable B/C ratios (i.e., values exceeding 1.0).

■ 5.7 Prioritization Process

Several improvements to the MassHighway prioritization process would help to manage the project pipeline more efficiently, conserve scarce human and financial resources, and communicate more realistic expectations to MPOs, other stakeholders, and the public. Our recommendations are as follows:

■ **Institute a more formal, documented, and transparent process.** A document should be prepared to guide the process, explaining policy objectives, the roles of prioritization criteria to help meet these objectives, instructions on identifying and submitting projects for consideration, and guidelines and criteria for approving changes to project scope and cost.

- **Project scope, cost, and impacts should be documented at nomination.** The project nomination process should itself be formalized and documented. MHD should develop and use a written form for project nomination, to be completed and submitted by project sponsors. The form should explicitly identify project scope, benefits, cost, and other impacts. Any mitigation work needed to have the project conform to environmental, community-imposed, or other requirements should be included in scope and cost.
- **Projects need to be vetted earlier, beginning at nomination.** Since nomination will precede design, estimates of costs, benefits, and impacts at nomination should be made using the best information and methods available. If these estimates are considered uncertain, only the design phase itself should be prioritized. Reviews of nomination forms should be conducted by the central office, and discussions with the project sponsor and MHD district representatives should be held to clarify and resolve any issues or questions. The more formal nomination process also allows consideration of financial constraints at project nomination, allowing earlier and better management of the project pipeline. Financial constraints can be expressed through tentative resource allocations among programs and between urban and rural projects where applicable. Final resource allocations should be made only after prioritization and any tradeoff analyses among programs.
- **Candidate projects need to be managed throughout the pipeline, from nomination to completion.** The pipeline needs to be managed, with current lists of active projects, project candidates, and their status. While priorities can be adjusted to reflect new information, such adjustments should be justified and documented. Once a nominated project has been accepted for prioritization, any subsequent changes to scope or cost should require formal review and approval, with approval authority based upon the magnitude of the proposed change. If a significant change in project scope or cost occurs, the project should be re-prioritized.

■ 5.8 Clearing the Backlog of Projects

The MassHighway now has a backlog of some 5,000 projects (including maintenance projects in its PROJIS project management system, of which many will never be constructed. There are about 1,300 active projects in some state of design, of which a considerable subset but not all will be built. The projects in the pipeline have consumed design resources to be “ready to go,” and management resources to track and report on them. Some projects have been in the pipeline a considerable period of time, and their priority may no longer be as high as that of competing projects that have entered the pipeline more recently. Clearing this backlog would enable the MassHighway to focus on current needs and priorities, be more responsive to project sponsors, and the public, and strengthen its credibility regarding the highway program. Elements recommended above for the updated prioritization process can be applied to help clear the existing backlog of projects, using the following process:

- Pre-screen the existing set of pipeline projects based on the applicable transportation-related criteria described earlier (quick estimates, not detailed computations); the length of time in the pipeline; and the readiness of the project to proceed.
- Organize the set of superior projects from this pre-screening within appropriate program categories, together with new projects.
- Have all projects compete for prioritization according to the process recommended in this memorandum, considering transportation and other policy-based criteria.
- Define a realistic annual funding constraint.
- For those projects with a superior ranking, proceed to the next phase of work (preliminary engineering, right-of-way acquisition, construction) consistent with the funding constraint.
- Move forward, managing each project in the pipeline, and checking priority at each work phase if there have been changes to scope or estimated cost.

6.0

Looking to the Long Term

The recommendations in this report are intended as the logical next step in the MBTA's and the MassHighway's ongoing efforts to improve their capital project prioritization processes and criteria. This report has introduced best-practice benchmarks as a guide to these further improvements. Their implementation will give the MBTA and the MassHighway more policy-driven and performance-based approaches that are consistent with each other, and can provide a model for adoption by other transportation agencies in the Commonwealth. While the improvements to be gained from these recommendations can be substantial, they represent a logical first step that can be implemented in the short term. In that context it is useful to think of longer-term steps that can provide additional improvement once these recommendations have been successfully implemented.

- The recommendations give both the MBTA and the MassHighway a strong foundation for communicating the State's policies, interests, and priorities regarding transportation investment to the MPOs, other stakeholders, and the public. In the Mass Highway's case in particular, given its emphasis on Preservation, it has the opportunity to communicate to MPOs the importance of the Preservation program, the rationale and analytic capabilities inherent in the PMS and BMS that underlie program recommendations, and the fact that, over time, the Preservation program represents strong geographic equity in the distribution of state transportation dollars among all MPOs.
- The MassHighway may find it useful to implement the recommended process and criteria within a mid-range plan or program document with a horizon of five to 10 years. This document, which would correspond to the MBTA's CIP, would bridge the gap between the MassHighway's Long-Range, Statewide Transportation Plan, and the Statewide Transportation Improvement Program.
- Several measures of cost-effectiveness have been defined for use by both agencies. As additional data become available, it is highly desirable that these cost-effectiveness measures evolve to benefit/cost analyses wherever possible.

- As experience grows in applying these recommendations, both the MBTA and the MassHighway can broaden their considerations of investment possibilities to cross-program and cross-modal comparisons and tradeoffs.
- There are specific technical advances that can be made.
 - For example, the MBTA can investigate technical measures of infrastructure and fleet condition to supplement and ultimately supplant its current age-based measures. Examples of condition measures include track geometry, measures of tunnel condition (cracking, leakage, etc.), fleet equipment availability, reliability of signal and switching systems, and ratings of station features and systems. Condition measures are useful to understand the performance of different technologies, and to be able to characterize better the improved performance due to investing in new technologies. However, moving to technical condition measures requires investing in data collection, so this step has been recommended as a long-term consideration.
 - The MBTA can develop measures and methodologies to more thoroughly analyze projects against new policy criteria, particularly those related to land use and sustainable development.
 - The MHD can consider moving from a reactive approach to safety project prioritization, based on high hazard locations (HHL), to a more proactive one based on analysis of potential risks. This approach would lead to recommendations of projects that would preclude HHLs from starting.

In addition to moving these processes forward technically, it is very important that both agencies thoroughly review these recommendations through their normal public and stakeholder involvement processes in order to ensure the goal of transparency. The implementation of these processes and criteria will have a major impact on the selection of transportation projects over the next decade. It is important that constituent groups understand them and buy into the basic approach in order to ensure the widest possible acceptance of the outcome of the process.

Appendices

Appendix A

Glossary

AADT – average annual daily traffic – a measure of daily traffic volume on a section of roadway.

BMS – bridge management system – computer application used to store bridge information, forecast bridge condition, and recommend a program of work.

Brownfield – parcel of land once used for industrial purposes.

Capital maintenance – projects that prolong the life of a roadway.

CIP – Capital Investment Program – list of planned capital transit projects within a five year time frame, produced by the MBTA.

CA/T – Central Artery/Tunnel Project – the “Big Dig.”

Chapter 90 projects – projects on local roads in Massachusetts not eligible for Federal Aid.

CTPS – Central Transportation Planning Staff – provides support to the Boston Metropolitan Planning Organization (MPO).

EOTC – Executive Office of Transportation and Construction.

Enhancement – a program category for projects that improve the quality of service provided by the existing transportation system.

Expansion – a program category for projects that add new service, new capacity, or new assets to a transportation system.

Friction course – a pavement treatment that restores the surface friction needed to avoid skidding, but does not add any structural strength to the pavement.

GIS – geographic information system.

HHL – high-hazard location – refers to a section of roadway or location or intersection with a high number of accidents or a high accident rate (number of accidents per million vehicle-miles driven).

HOV lane – high-occupancy-vehicle lane.

Infills – developments on vacant or underutilized parcels of land.

ITS – Intelligent Transportation System – refers to devices that help manage more efficient traffic movement in real time.

LOS – Level of Service – reflects the quality of traffic flow and speed on a highway section, based on the ratio of traffic volume to roadway capacity.

LRP – Long-Range Plan, a document required by Federal law that sets out transportation needs, options, and proposed actions over a 20-25 year time frame.

LRTP – Long-Range Transportation Plan – see Long Range Plan.

MassHighway – Massachusetts Highway Department.

MBTA – Massachusetts Bay Transportation Authority.

MHD – Massachusetts Highway Department.

MPO – Metropolitan Planning Organization – agency responsible for developing plans and programs for federally funded transportation projects in an urbanized transportation.

NBI – National Bridge Inventory – federally mandated set of bridge data required to be obtained via bridge inspections at least every two years.

Non-Deficient bridges – bridges in fair condition or better, as defined by federal guidelines.

Overlay – typically a layer of asphalt placed on top of an existing pavement to restore good surface conditions, ride quality, and pavement strength.

PMT – Program for Mass Transportation – a long-range plan for transit projects in the Boston area, produced by the MBTA.

Project pipeline – a set of active projects in various stages of their life cycle, ranging from inception and nomination through planning, programming, bid advertisement, construction, and completion.

Pontis® – bridge management system (BMS) currently used by MassHighway.

PRC – Project Review Committee – MassHighway committee responsible for ensuring that proposed projects are eligible for federal funds.

Preservation – a program category for projects that maintain infrastructure or fleet assets in a state of good or optimal repair.

PROJIS – Project Information System – computer application used by MassHighway to track projects through the project pipeline.

PSI – pavement serviceability index – measure of pavement condition ranging from zero to five (five is a perfectly smooth pavement and zero is impassable).

SN – skid number – measure of pavement condition that reflects the level of friction between a tire and the pavement surface, typically measured in wet conditions.

State of optimal repair – the state of repair that will maximize the life-cycle cost of an asset.

TAZ – traffic analysis zones – geographic areas used during land-use planning.

TIP – Transportation Improvement Program – federally mandated three-year list of transportation capital projects.

Useful life – number of years for which an asset can serve its intended function.

VMT – vehicle miles traveled, a product of the number of vehicles and the distance they travel on a section of road or street.

Appendix B

FTA New Starts Criteria Thresholds

B.1 Cost-Effectiveness

As stated in their guidance, FTA applies the following cost-effectiveness thresholds:

Rating	Description	Thresholds (cost per hour of transportation system user benefits)
5	High	\$9.99 and under
4	Medium-High	\$10.00 - \$12.99
3	Medium	\$13.00 - \$19.99
2	Low-Medium	\$20.00 - \$24.99
1	Low	\$25.00 and over

B.2 Mobility Improvements

TABLE B.1
Estimated Thresholds for Normalized Travel Time Savings
 (BENEFITS PER PASSENGER MILE)

Rating	Description	Thresholds (millions hours)
5	High	Above 8.00
4	Medium-High	4.00 – 8.00
3	Medium	2.00 – 4.00
2	Low-Medium	1.00 – 2.00
1	Low	Under 1.00

TABLE B.2
Estimated Thresholds for Employment Near Stations

Rating	Description	Thresholds (employees per station)
5	High	Above 20,000
4	Medium-High	8,000 – 20,000
3	Medium	4,000 – 8,000
2	Low-Medium	1,727 – 4,000
1	Low	Under 1,727

TABLE B.3

Estimated Thresholds for Low-Income Households Near Stations

Rating	Description	Thresholds (households per station)
5	High	Above 1,000
4	Medium-High	300 – 1,000
3	Medium	200 - 300
2	Low-Medium	50 - 200
1	Low	Under 50

B.3 Operating Efficiencies

Operating efficiencies are not formally considered in the recommendations process, only for Congressional reporting.

System Operating Cost per Passenger Mile

FTA states that all projects that submit information in this category are rated medium (3).

For FY 2004 projects, the range for change in operating cost per passenger mile, New Starts funding compared to baseline funding, was $-\$0.88$ to $\$0.06$ (reduced cost of $\$0.88$ to increased cost of $\$0.06$).

B.4 Environmental Benefits

Environmental benefits are not formally considered in the recommendations process, only for Congressional reporting.

Projects are rated “High” if they reduce pollutants in non-attainment areas.

Projects are rated “Medium” if they reduce pollutants in attainment areas.

Other projects are rated “Low.”

Appendix C

Example Economic Development and Land-Use Criteria

TABLE C.1
Example Economic Development and Land-Use Criteria
 AUGUST 11, 2003

Criterion	Specific Measure	Data/Assessment Methods	Descriptions/Approximate Ranges or Thresholds
<i>All Expansion Projects</i>			
Serves existing urbanized area ¹	Classify by extent to which project falls within a census-defined urbanized area (UA)	Overlay project on census UA boundaries using GIS	<ul style="list-style-type: none"> • High – 90-100% • Medium – 66-89% • Low – <66%
Brownfields & Infill	Improvement serves one or more Brownfields and/or infill ² sites targeted for redevelopment (yes/no)	Discussion with local planners to identify targeted sites	<ul style="list-style-type: none"> • Transportation, economic development, and other benefits of project (reflecting planned/anticipated development on site) are sufficient to justify project based on same benefit criteria applied to other projects³
Population/employment served	Average population (and/or employment) density within a 1/2 mile radius of stations. <ul style="list-style-type: none"> • High • Medium • Low 	Population density could be computed through GIS analysis of census data. A similar analysis of employment density could be computed for stations where TAZ-level data exists (e.g., from CTPS).	Population density (persons/square mile) <ul style="list-style-type: none"> • High – > 5,000 (urban) • Medium – 1,000 – 5,000 • Low – < 1,000 Employment density on a similar scale?
<i>All Expansion Projects</i>			
Population/employment served	Average population (and/or employment) density within a 1/2 mile radius of stations. <ul style="list-style-type: none"> • High • Medium • Low 	Population density could be computed through GIS analysis of census data. A similar analysis of employment density could be computed for stations where TAZ-level data exists (e.g., from CTPS).	Population density (persons/square mile) <ul style="list-style-type: none"> • High – > 5,000 (urban) • Medium – 1,000 – 5,000 • Low – < 1,000 Employment density on a similar scale?

¹ This is similar to the concept of “priority funding areas” such as applied in Maryland or New Jersey, or designated “downtowns” and “growth areas” as applied in Vermont. Absent such designations in Massachusetts, the census definition of an urbanized area is used as a proxy. Urbanized area boundaries cover much of the Commonwealth, and may be broader than those preferred for defining “Smart Growth” areas.

² Infill can be defined as “development on a vacant or substantially vacant tract of land surrounded by existing development.”

³ In other words, a highway project, particularly an expensive one, cannot be justified solely because it goes past a one-acre Brownfields site. The project still needs to pass a cost-benefit test.

TABLE C.1
Example Economic Development and Land-Use Criteria
 CONTINUED

Criterion	Specific Measure	Data/Assessment Methods	Descriptions/Approximate Ranges or Thresholds
<i>Transit Expansion Project (cont.)</i>			
Existing land use character	Classify by percent of station areas meeting “transit-supportive” criteria: <ul style="list-style-type: none"> • High – At least $\frac{2}{3}$ of station areas • Medium – $\frac{1}{3}$ to $\frac{2}{3}$ of station areas • Low – $< \frac{1}{3}$ of station areas 	Qualitative assessment of station areas ($\frac{1}{4}$ to $\frac{1}{2}$ mile radius)	Transit-supportive criteria: <ul style="list-style-type: none"> • Streets leading to transit station(s) have street-fronting buildings w/ $< 20'$ setbacks • Five-plus retail establishments within a five-minute walk of the station platform • Sidewalks and pedestrian crossings throughout station area ($\frac{1}{4}$ to $\frac{1}{2}$ mile radius) • Significant proportion of residential development in station area is multi-family • Limited off-street parking, preferably placed behind buildings Not transit-supportive: <ul style="list-style-type: none"> • Large setbacks ($> 20'$) • Parking in front of or surrounding buildings • Mostly single-family homes and/or free-standing commercial buildings • At least 25% of streets without sidewalks or intersections without pedestrian crossings
Transit-supportive zoning in station areas	Classify by percent of station areas meeting “transit-supportive” criteria: <ul style="list-style-type: none"> • High – At least $\frac{2}{3}$ of station areas • Medium – $\frac{1}{3}$ to $\frac{2}{3}$ of station areas • Low – $< \frac{1}{3}$ of station areas 	Review of zoning codes in station areas	Transit-supportive criteria: <ul style="list-style-type: none"> • Multi-family residential areas with at least 15-20 dwelling units/acre; single family areas with at least eight to 10 units/acre • Commercial FAR of at least 1.0 • Mixed-use zoning on main streets and adjacent to station that includes office, retail, residential, and/or other uses within the same building or within close proximity. • Zoning that establishes maximum building setbacks (e.g., 20 feet or less)

TABLE C.1
Example Economic Development and Land-Use Criteria
 CONTINUED

Criterion	Specific Measure	Data/Assessment Methods	Descriptions/Approximate Ranges or Thresholds
<i>Highway Expansion Project</i>			
Corridor planning	Local jurisdictions and the state have participated in the development of, and approved, a corridor plan that addresses land use, access management, and secondary and cumulative impacts (yes/no)	Review planning process, resulting plan(s), and endorsements	<p>Corridor plan should address the following issues (at a minimum):</p> <ul style="list-style-type: none"> • Provisions for access management, including access points, permitting, zoning, and local access roads • Protections for environmentally sensitive areas and other community open space; community plans and zoning have been enacted to regulate development in a locally acceptable manner • Provisions for multimodal access (pedestrian, bicycle, transit/intermodal access)
Context-sensitive design	Design has been developed in consultation with and approved by affected communities (yes/no)	Review planning process, design, and endorsements	<ul style="list-style-type: none"> • Design features minimize environmental and community impacts • Flexibility demonstrated in application of design standards (if relevant/necessary) • Design incorporates needs of alternative mode users (pedestrian, bicycle)
Interchange location	Local jurisdictions and the state have participated in the development of plans and policies to manage growth in the interchange sphere of influence ⁴ (yes/no)	Review planning process, resulting plan(s), and endorsements	<ul style="list-style-type: none"> • Community planning process has addressed potential development resulting from the interchange • Access management plan developed for major roads within 1 mile of the interchange • Appropriate zoning policies and protections for environmentally sensitive areas adopted • Development allowed under zoning will not create over-capacity situations on roads and intersections

⁴ The interchange sphere of influence could range anywhere from two to five miles depending upon the location of the interchange, alternate routes, development pressures on the area, etc.



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